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EFFICIENCY OF THE USE OF THE "*PENISETUM PURPUREUM*" PLANT FOR AN ADEQUATE BALANCE IN THE C / N RELATIONSHIP AS A MEASURE TO CONTROL THE PRODUCTION OF SULF HYDRIC ACID AND THUS PREVENT ENGINE COHERRETION

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Abstract

The results of this study undoubtedly demonstrate that the plant Penisetum purpureum is a plant with great energy potential, and can become a great solution to be used as a source of biomass to produce biogas and therefore for the production of energy electric as an alternative energy source. In this experiment, we have comparatively studied three mixtures of substrate of animal origin (sardinia) and substrate of vegetal origin (Penisetum purpureum), with the purpose of determining the variables corresponding to different proportions in the mixtures taking as parameter the C / N ratio. ; and its incidence in the control and reduction of hydrogen sulfide in the biodigester. Laboratory analyzes were carried out for fresh weight, dry weight, volatile mass and biogas production, methane production and also at the level of a biogas production plant the volume of hydrogen sulfide was analyzed according to the different mixtures proposed. The main objective of this work was to compare the total production of biogas and methane versus the increase in the production of hydrogen sulfide and the control and reduction of this through the use of the species Penisetum purpureum as a contribution of carbon within the C / N ratio.

Key words**:** *biogas production, methane gas production, C / N ratio, Penisetum purpureum species, renewable energies,, Costa Rica*

INTRODUCTION

Obtaining fuels from different types of biomass, specially farming, has been explored for a long time. The attention in this products has increased in recent years due to multiple factor that have made us look for different energy sources, such as biogas, which may be inefficient if is not produced in the right way [7].

The interest of this study explains how the deterioration of the motors in mesophilic biodigestion stations has grown, as a result of the corrosion caused by the high content of hydrogen sulfide in the biodigestor, in some cases it increased more than 1,500 ppm when the permitted is in ranges from 50 to 100 ppm [2].

In most biogas stations, especially those that feed on substrate of animal origin, the problem is notorious and very harmful [9]. For this reason, this study is based on the need to develop an ideal mix of substrates taking into account the C/N ratio, which allows controlling and decreasing the production of hydrogen sulfide within the biodigestor [6], since it can be demonstrated that less quantity of hydrogen sulfide is better quality and quantity of both biogas and methane [8].

Taking into account this C / N ratio, we have also concluded that the species *Penisetum purpureum* has a great potential as an energy plant.

Table 1. Comparison between different energy crops yields

Energy crop	Yield Ton/ha	Energy MJ/kg	Price SUS/ton	Energy yield GJ/ha)	Income SUS/ha
Panicum virgatum	25	17.9	50	448	1,250
Miscanthus	39	17.9	50	698	1,950
Jatropha	1.6-2.0	42	700	67-84	1,120-1,400
Aceite de Palma	3.5-5.0	42	700	147-210	2,450-3,500
King Grass - Penisetum sp.	100-135	18.4	50	1,840-2,484	5,000-6,750

Source: Kukkonen, 2010.

In Table 1 we can see the benefits of this plant comparing it with other species that can provide us with the necessary carbon, to make more efficient the production of biogas with a hydrogen sulfide within the allowed parameters.

It is also important to mention that this species of plant Pennisetum purpureum, could become a solution to replace the use of corn, which in fact is already being restricted for the production of energy due to its great importance in food safety [10].

The main objective of the investigation:

Analyze different mixtures between substrates of animal origin (sow), from a pig farm; and substrates of plant origin (Pennisetum purpureum), with an adequate balance between the C/N ratio, which allows controlling the production of hydrogen sulfide.

Among the specific objectives we analyzed:

• Feeding the biodigester with different types of mix with contributions of sardinia and Pennisetum purpureum

•Analysis of variables such as pH, total solids, volatile solids and chemical oxygen demand (COD).

• Analysis of the relationship C /N

• Analysis of the production both in quantity and quality of biogas and methane versus the increase in the production of sulfhydric acid.

MATERIALS AND METHODS

The objective of this research is to understand how the use of a raw material of purely animal origin can affect the performance of a mesophilic biodigestion system both in quality and quantity of biogas or by-products generated in the process, in addition to this is intended to make known how the C / N ratio affects the aforementioned parameters and their role in reducing the production of hydrogen sulfide (H2S).

To carry out this study, the sources of carbon and nitrogen were studied separately, in this case the potential of *Pennisetum purpureum* was analyzed in the production of biogas, for which the sectioned plant was studied in each of its organs and its contribution in biomass (total solids) for the biodigestion process [12].

The potential for biogas production was analyzed at the laboratory level in 2 liters digesters, and the production potential of methane (CH4) was also obtained.

Alternating to the study conducted in *Pennisetum purpureum*, the production of biogas, methane and hydrogen sulfide was analyzed in a biodigester fed only with a source of raw material of animal origin, in this case pig manure (sowing). In addition, mixtures of different proportions of C / N between *Pennisetum purpureum* and the sow were made in order to study the change in the production of methane in its different proportions and if there is a reduction in the production of hydrogen sulfide, which is a primary objective in biodigestion systems currently used as the cost of repair of a motor damaged by hydrogen sulfide can amount to hundreds of thousands of euros [3].

RESULTS AND DISCUSSIONS

Initially, a comparative analysis was made of different green carbon sources in which Pennisetum purpureum was selected as the source with the greatest potential for the generation of biogas and with a higher quality index.

Table 2. Comparative analysis of different sources of biomass for electricity generation

Source	Biogas production (L / kg WS)	Methane contend (%)	Methane production (L / kg SV)	Electricity production (Kw / h * T)
Cow manure	380	55	30.096	105
Zea mais	610	52	61,52	215
Variety P. purpureum de Bajura	650	52	72.2	252
Variety P. purpureum de Altura	610	52	72.3	253
Sorghum bicolr, Var. saccharatum	620	52	60.15	207

Source: Viquez Saborio C., 2015 [14].

Among the varieties that were analyzed, Pennisetum purpureum was selected because of its great biogas production capacity in L / kg of dry matter, as can be seen in table 2, and it was also the one with the highest rate of

methane production. in L / kg of volatile solids.

Table 3. Biomass of Pennisetum purpureum plants and structure of components

Part of the plant	Green mass (G)	%	Total solids (G)	%	SV Content %
Root	303.5	43.0	63.1	32.6	20.8
Stem	105.1	14.9	24.2	12.5	23.1
Leaf	296.5	42.1	106.1	54.8	35.8
Total	705.1	100	193.4	100	27.4

Source: Viquez Saborio C, 2017, [15].

As can be seen in Table 3, the *Pennisetum purpureum* variety has a high content of both total solids and volatile solids, which makes it one of the best green raw materials that can be used in a biodigestion system[4].

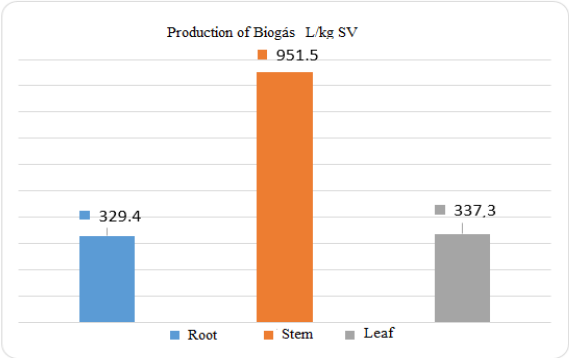

Fig 1. Biogas production by vegetative organ.
(Source: Viquez Saborio C, 2017, [15].

In *Penisetum purpureum* the total green biomass was 705.1 g / plant and the dry substance was 193.4 g / plant. In the biomass structure, the leaf organ represented the largest proportion of 42.1% of the green biomass and 54.8% of the dry matter produced by the plant.
The results suggest that the variety *Penisetum purpureum* is the grass with the greatest potential in energy generation due to its high efficiency at the level of total and volatile solids generated by vegetable organ.
Not only is it important to evaluate the behavior of biogas production of vegetative substrates, but also to evaluate the behavior of these in the production of methane and the effect obtained from this mixture in the generation of hydrogen sulphide [1], which is one of the objectives of the study, since an efficient biodigestion system has an adequate balance in the organic part, which is made up of 10% of the components of the mixture that must be used in a biodigester.
An analysis of the biogas production was carried out in a system fed only by a source of animal origin (sowing).
Figure 2 shows how an almost exponential increase in the production of hydrogen sulfide (H2S) in the biodigester is occurring, which is due to the low C: N ratio in the system.

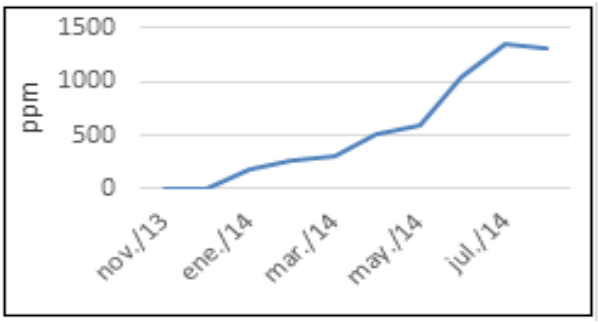

Fig. 2. Content of sulfuric acid in the biodigester fed only with pig manure.
Source: Viquez Saborio C, 2017 [15].

Levels of H2S above 1,000 ppm cause serious structural damage [16], in this case it is shown in Figure 3 how the engine of the biodigester is oxidized and degraded.

Fig. 3. Degradation of the engine due to the high content of hydrogen sulfide in biodigester
(Source: Viquez Saborio C, 2017, [15].

Analysis of the behavior of the biodigester in terms of the production of H2S with a balance in the C / N ratio.
Before planting in the biodigester, it was carried out in a hydrolysis process that was carried out under the conditions in Costa Rica,

it was a pre-fermentation process that did not last more than 10 days [11].

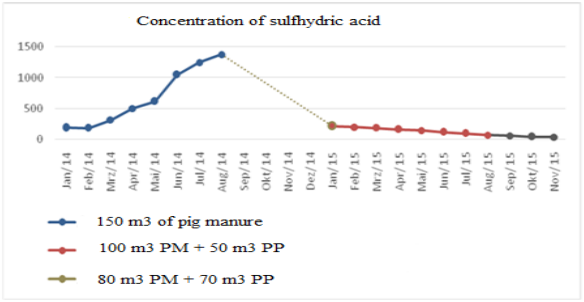

Fig. 4. Concentration of sulfuric acid after feeding with different types of biomass.
Source: Viquez Saborio C, 2017, [15].

How much biogas began to go with biomass, hydrogen sulphide began to decrease as shown in the previous figure.
The more we increase the amount of biomass through the *Pennisetum purpureum* plant, the lower is the sulfuric acid and we increase the production of biogas and methane in L / kg SV per day, as can be seen in the following figures.

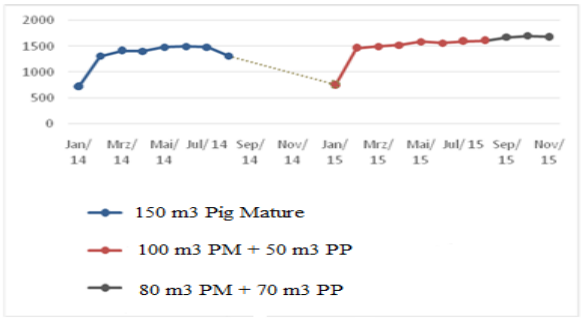

Fig. 5. Production of biogas after feeding different types of biomass
Source: Viquez Saborio C, 2017, [15].

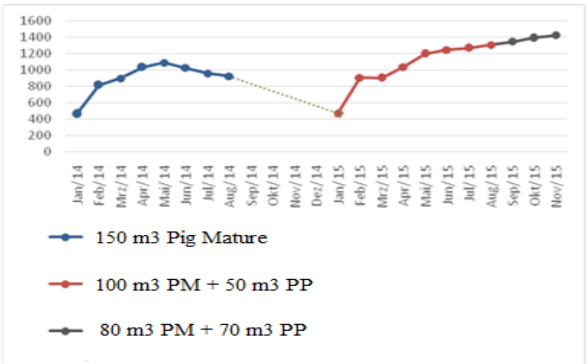

Fig. 6. Methane production after feeding with different types of biomass
Source: Saborio C, 2017, [15, 16, 17].

These data, we can conclude that the greater the amount of plant biomass (*P. purpureum*) used in the biodigester than the biomass from animal manure; the greater the amount of methane and the lower the amount of H2S. This is the most important part of anaerobic digestion because the concentration of methane depends on the caloric energy, which is what most interests us to produce good and efficient electricity [13].

CONCLUSIONS

The comparative analysis of the species showed that the *Penisetum purpureum* variety achieved a higher biomass production (705 g / plant) compared to the other sources of green biomass that were studied.
An increase in the amount of biogas generated in the biodigester was recorded when increasing the proportion of *Penisetum purpureum* used in the biodigestion mixture.
There was an increase in the quality of the biogas generated in the biodigester when the proportion of *Penisetum purpureum* used in the biodigestion mixture was increased as there was a significant increase in the production of CH4.
Research on different mixtures shows that the maximum level of biogas production is used when mixtures are used at a ratio close to 1: 1 between manure and plant biomass [5].
It was shown that by improving the C / N ratio in the biodigestion system there is a significant reduction in the amount of hydrogen sulphide [15] and thus preventing damage to engines or structures that could generate a malfunction of the biodigestion system.

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